

Total Maximum Daily Loads for Bacteria and Sediment in the Christina River Watershed Pennsylvania, Delaware, and Maryland

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those waterbodies identified as impaired by the state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint and natural background sources, including a margin of safety (MOS), which may be discharged to a water quality-limited waterbody without violating water quality standards.

TMDLs are defined as the summation of the point source wasteload allocations (WLAs) plus the summation of the nonpoint source load allocations (LAs) plus a MOS and are often shown as:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

The TMDL is a written plan and analysis established to ensure that a waterbody will attain and maintain water quality standards. The TMDL is a scientifically-based strategy that considers current and foreseeable conditions, the best available data, and accounts for uncertainty with the inclusion of a MOS value.

The TMDLs are to achieve and maintain the states' existing water quality standards and must meet the following eight regulatory requirements pursuant to 40 CFR Part 130.

1. The TMDLs are designed to implement the applicable water quality standards.
2. The TMDLs include a total allowable load as well as individual WLAs and LAs.
3. The TMDLs consider the impacts of background pollutant contributions.
4. The TMDLs consider critical environmental conditions.
5. The TMDLs consider seasonal environmental variations.
6. The TMDLs include a MOS.
7. There is reasonable assurance that the proposed TMDLs can be met.
8. The TMDLs have been subject to public participation.

As interstate TMDLs, both Pennsylvania and Maryland have the responsibility of meeting downstream Delaware's water quality standards.

As a result of water quality and biological investigations conducted by the Pennsylvania Department of Environmental Protection (PADEP), Delaware Department of Natural Resources and Environmental Control (DNREC), and Maryland Department of Environment that identified

observed impacts on aquatic life, many streams in the Christina River Basin have been listed on the states' Section 303(d) lists of impaired waters. Parts of the watershed are heavily impacted by urbanization and are listed as impaired due to problems associated with elevated bacteria levels and sediment (also referred to as siltation). This study will fulfill the requirements for bacteria and sediment TMDL development for waters in the Christina River Basin included in the Section 303(d) lists for Pennsylvania and Delaware. A related study addresses those impairments resulting from nutrients and low dissolved oxygen concentrations.

1.1 Historical Perspective

In 1991, at the request of DNREC and PADEP, the Delaware River Basin Commission (DRBC) agreed to mediate water management issues in the "interstate" Christina River Basin. The issues included interstate and intrastate coordination of monitoring, modeling, and pollution controls; balancing the conflicting demands for potable water while maintaining necessary minimum pass-by requirements to sustain aquatic life; protection of vulnerable, high quality scenic and recreational areas; restoration of wetlands and other critical habitats; and implementation of Delaware's Exceptional Recreational or Ecological Significance (ERES) objectives. A comprehensive basin approach was needed to address these management issues.

The DRBC facilitated a series of meetings with DNREC, PADEP, EPA, Chester County Water Resources Authority (CCWA), and the United States Geological Survey (USGS). EPA funded a study by Scientific Applications International Corporation for completion of an initial data assessment and problem identification study for the non-tidal portion of Brandywine Creek. The findings of this study, *Preliminary Study of the Brandywine Creek Sub-basin, Final Report, September 30, 1993*, provided a framework for use in a multi-step TMDL study for the entire Christina River Basin. The two States, DRBC and EPA, reached agreement in late 1993 to initiate a cooperative and coordinated monitoring and modeling approach to produce Christina River Basin TMDLs under low-flow conditions. EPA established the Christina River Basin Low-Flow TMDL on January 19, 2001 (later revised on October 8, 2002). See Region III web site at <http://www.epa.gov/reg3wapd/tmdl/>.

Even as the parties reached agreement on how best to address the impacts of pollutants during low-flow conditions, they recognized that additional efforts would be necessary to address the distinct water quality problems resulting from nonpoint sources of pollutants during high-flow or variable flow conditions. In 1993, EPA recommended that DRBC expand the effort to consider high-flow conditions. As a result, the Christina Basin Water Quality Management Committee (CBWQMC) was created with the purpose of addressing the applicable water quality problems and management policies on a watershed scale. The CBWQMC represents a variety of stakeholders and interested parties including the Brandywine Valley Association/Red Clay Valley Association, Chester County Conservation District, Chester County Health Department (CCHD), Chester County Planning Commission, CCWA, DNREC, Delaware Nature Society, DRBC, New Castle County Conservation District (NCCD), PADEP, EPA Region III, USGS, United States Natural Resources Conservation Service (USDA-NRCS) and the Water Resources Agency for New Castle County.

The CBWQMC developed a unified, multi-phased, five-year Water Quality Management Strategy (WQMS) that (1) addresses the water quality problems through voluntary watershed/water quality planning and management activities and (2), establishes appropriate TMDLs. The reason for separating the development of TMDLs to address water quality

problems between low-flow and high-flow TMDLs is that each scenario has different and distinct pollutants and problems at different flow regimes.

Since 1995, the CBWQMC has been conducting activities set forth in the WQMS designed to implement programs aimed at protecting and improving water quality. These activities include Geographic Information System (GIS) watershed inventory, water quality assessment, watershed pollutant potential and prioritization, stormwater monitoring, best management practices (BMP) Implementation projects and public education/outreach. A summary of these activities can be found in *Phase I and II Report, Christina River Basin Water Quality Management Strategy, May 1998*, and *Phase III Report, Christina Basin Water Quality Management Strategy, August 5, 1999*. These reports describe ongoing efforts to provide pollution control and restore water quality within the Christina River Basin.

Both Pennsylvania and Delaware have identified multiple segments and pollutants in the Christina River Basin on their respective lists of impaired waters still requiring the development of a TMDL. Maryland has identified biological impairments in the West Branch Christina River. The CWA requires that upstream waters must meet the applicable water quality standard of the downstream state at or before the state line. In other words, both Maryland and Pennsylvania are required to meet Delaware's water quality standard at the Delaware State line.

Concurrent with the water quality improvement activities taking place within the Christina River Basin, EPA settled two civil lawsuits regarding EPA's oversight of the TMDL programs of Pennsylvania and Delaware. Both suits alleged violations of the CWA, the Endangered Species Act, and the Administrative Procedures Act. The settlement of the Pennsylvania matter, American Littoral Society and the Public Interest Research Group v. EPA, Civil No. 96-489 (E.D. Pa), effective date April 9, 1997, requires certain numbers of TMDLs by certain dates but gives discretion to Pennsylvania and EPA as to which TMDLs must be completed.

The settlement of the Delaware lawsuit, American Littoral Society and Sierra Club v. EPA, Civil Action No. 96-591 (SLR) (D.De), effective date August 9, 1997, sets forth specific deadlines for EPA relating to specific waters and TMDLs in the Christina River Basin. Under the schedule set forth the settlement, Delaware was to establish low-flow TMDLs for all water quality limited segments (except for those impaired by bacteria), including Brandywine Creek, Christina River, Red Clay Creek and White Clay Creek, by December 31, 1999. The Delaware settlement also expected Delaware to establish high-flow TMDLs by December 31, 2004. Pursuant to the Delaware agreement, EPA is required to establish TMDLs within one year should Delaware fail to do so.

1.2 Background Information

The Christina River Basin (Hydrologic Unit Code 02040205) covers an area of about 564 square miles and is located in Chester County, Pennsylvania, New Castle County, Delaware, and Cecil County, Maryland (Figure 1-1). Major streams include the Christina River (tidal and nontidal), Brandywine Creek (tidal and nontidal), Red Clay Creek and White Clay Creek (tidal and nontidal). These streams are designated as habitat for aquatic life, for municipal and industrial water supplies, and for recreational purposes. The Christina River Basin drains to the tidal Delaware River at Wilmington, Delaware.

The Christina River Basin is composed of diverse land uses including urban, rural and agricultural areas. Urban areas in the watershed include greater Wilmington and Newark, Delaware, and the Pennsylvania towns of West Chester, Downingtown, Kennett Square, Coatesville, Parkesburg, Honey Brook, Avondale and West Grove. The land use distribution within the basin is summarized in Table 1-1 and the Brandywine Creek Watershed subbasins are shown in Figure 1-1 and identified in Table 1-2.

Table 1-1. Christina River Basin land use summary (square miles)

Land Use	DE/MD	Pennsylvania	Total	%
Urban/Suburban	87	108	195	34
Agricultural	18	160	178	31
Open Space or Protected Lands	21	5	26	5
Wooded	37	123	160	28
Water/other	3	3	6	2
Total	166	399	565	100

Source: Phase I/II Report Christina River Basin Water Quality Management Strategy (CBWQMC - May 1998)

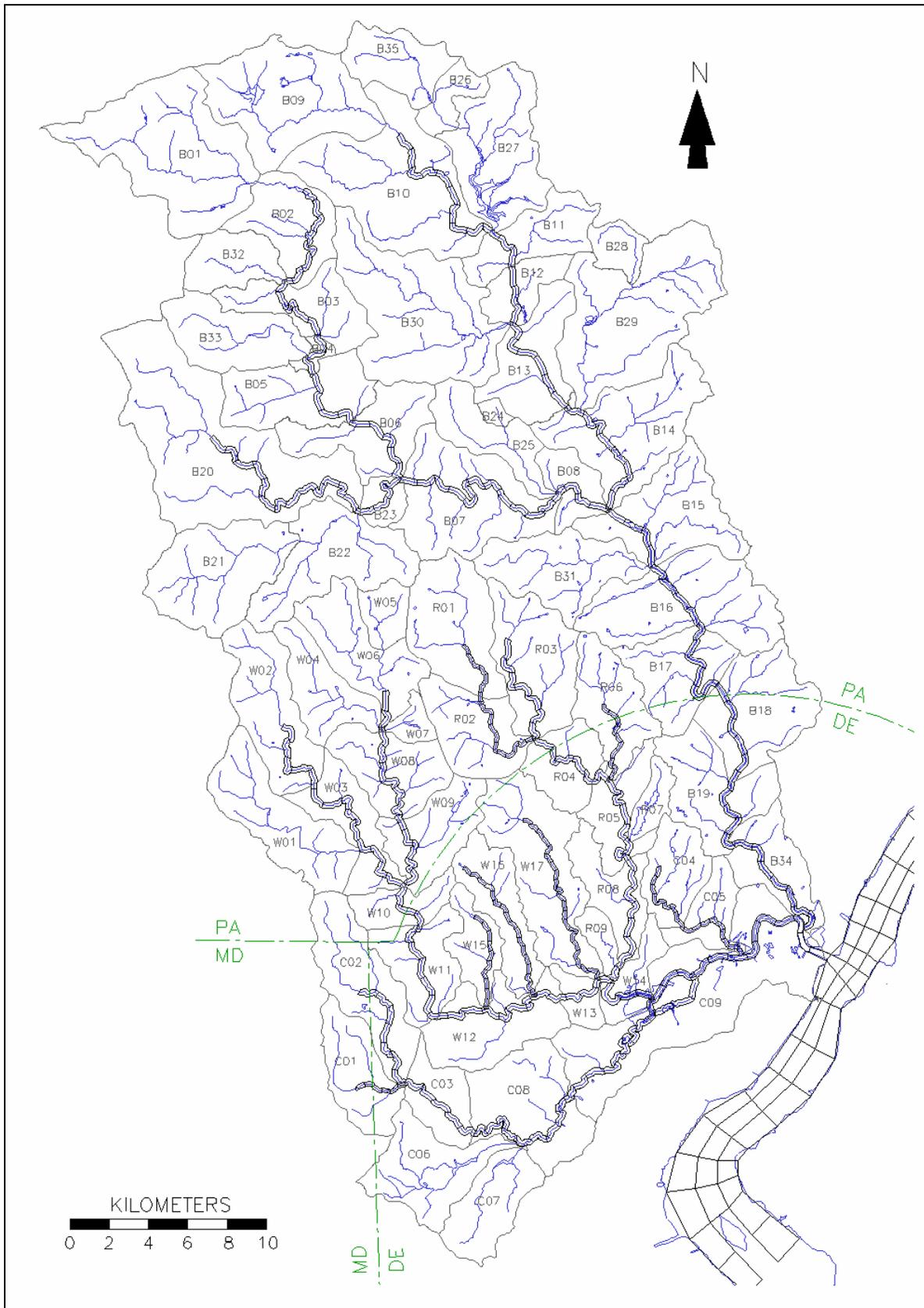


Figure 1-1. Christina River Basin delineation of HSPF model subbasins and EFDC model grid.

Table 1-2. Subbasins in the HSPF models of the Christina River Basin

Subbasin	Stream Name	Area (mi ²)	Subbasin	Stream Name	Area (mi ²)
<i>Brandywine Creek Watershed</i>			<i>White Clay Creek Watershed</i>		
B01	Upper Brandywine Creek West Br.	18.39	W01	White Clay Creek West Br.	10.23
B02	Brandywine Creek West Branch	7.38	W02	Upper White Clay Creek Middle Br.	9.51
B03	Brandywine Creek West Branch	6.76	W03	White Clay Creek Middle Br.	6.35
B04	Brandywine Creek West Branch	0.80	W04	Trib. to White Clay Creek East Br.	6.20
B05	Brandywine Creek West Branch	8.82	W05	Trib. to White Clay Creek East Br.	2.65
B06	Brandywine Creek West Branch	8.06	W06	Upper White Clay Creek East Br.	8.57
B07	Brandywine Creek West Branch	13.46	W07	Trout Run	1.37
B08	Brandywine Creek West Branch	3.62	W08	White Clay Creek East Branch	7.47
B09	Upper Brandywine Creek East Br.	14.68	W09	White Clay Creek East Branch	6.85
B10	Brandywine Creek East Branch	18.31	W10	White Clay Creek	3.58
B11	Brandywine Creek East Branch	6.31	W11	White Clay Creek	6.53
B12	Brandywine Creek East Branch	3.70	W12	White Clay Creek	8.76
B13	Brandywine Creek East Branch	7.94	W13	White Clay Creek	2.08
B14	Brandywine Creek East Branch	12.92	W14	White Clay Creek	3.41
B15	Brandywine Creek	10.36	W15	Muddy Run	3.89
B16	Brandywine Creek	14.06	W16	Pike Creek	6.65
B17	Brandywine Creek	7.51	W17	Mill Creek	13.00
			<i>Red Clay Creek Watershed</i>		
B18	Brandywine Creek	10.37	R01	Upper Red Clay Creek West Branch	10.08
B19	Brandywine Creek	8.64	R02	Red Clay Creek West Branch	7.39
B20	Upper Buck Run	25.54	R03	Red Clay Creek East Branch	9.90
B21	Upper Doe Run	11.05	R04	Red Clay Creek	5.11
B22	Lower Doe Run	10.96	R05	Red Clay Creek	5.24
B23	Lower Buck Run	1.95	R06	Burroughs Run	7.10
B24	Tributary to Broad Run	0.60	R07	Hoopes Reservoir	2.10
B25	Broad Run	5.83	R08	Red Clay Creek	5.38
B26	Marsh Creek	2.61	R09	Red Clay Creek	1.72
B27	Marsh Creek	11.54	<i>Christina River Watershed</i>		
			C01	Christina River West Branch	6.70
B28	Tributary to Valley Creek	2.40	C02	Upper Christina River	9.73
B29	Valley Creek	18.21	C03	Christine River	4.47
B30	Beaver Creek	18.08	C04	Upper Little Mill Creek	5.37
B31	Pocopson Creek	9.19	C05	Little Mill Creek	3.84
B32	Birch Run	4.66	C06	Muddy Run	8.64
B33	Rock Run	8.03	C07	Belltown Run	6.37
B34	Brandywine Creek	6.05	C08	Christina River	10.70
B35	Upper Marsh Creek	5.80	C09	Lower Christina River	21.90

Both PADEP and DNREC identified the impaired stream segments based on historical monitoring data. The two state agencies use different bacterial indicators in their respective water quality standards for pathogens. Pennsylvania uses fecal coliform bacteria as an indicator

of bacteria contamination whereas Delaware uses *enterococcus* bacteria. Fecal coliforms are a specific kind of coliform bacteria found primarily in the intestinal tracts of mammals and birds. These bacteria are usually released into the environment through human and animal feces. The presence of fecal coliform bacteria pollution may come from storm water runoff, pets, wildlife, and human sewage. If they are present in high concentrations in recreational waters and are ingested while swimming or enter the skin through a cut or sore, they may cause disease, infections, or rashes. *Enterococcus* is a common bacterium normally found in the intestinal tract of warm-blooded animals including humans. The presence of *enterococci* in surface water samples is used as an indicator of the presence of human sewage. *Enterococci* have a greater correlation with swimming-associated gastrointestinal illness in both marine and fresh waters than other bacterial indicator organisms, and are less likely to die off in saltwater.

1.3 Impairment Listing

TMDL development for this study is limited to bacteria and sediment impairments. Listings of the water segments in the Christina River Basin impaired by bacteria and sediment are provided in this section.

1.3.1 Bacteria Impairments

There are six subbasins containing stream segments on Pennsylvania’s Section 303(d) list for bacteria impairment, and 19 waterbodies listed for bacteria impairment on Delaware’s Section 303(d) list (see Table 1-3). There are no streams in the Maryland portion of the basin listed for bacteria impairment.

Table 1-3. Segments impaired by bacteria in Christina River Basin.

Assessment ID	Waterbody Name	Size	Potential Source
Pennsylvania			
Subbasin R01	Mainstem and tributaries W. Br. Red Clay Creek	13.2 mi	NPS
Subbasin R02	Mainstem and tributaries W. Br. Red Clay Creek	18.9 mi	NPS
Subbasin R03	Mainstem and tributaries E. Br. Red Clay Creek	15.9 mi	NPS
Subbasin R04	Mainstem and tributaries Red Clay Creek	2.4 mi	NPS
Subbasin R06	Tributaries Red Clay Creek	8.6 mi	NPS
Subbasin W04	Tributaries E. Br. White Clay Creek	6.0 mi	PS
Delaware			
DE040-001	Lower Brandywine Creek	3.8 mi	PS, NPS
DE040-002	Upper Brandywine Creek	9.3 mi	PS, NPS
DE260-001	Red Clay Creek	12.8 mi	PS, NPS
DE260-002	Burroughs Run	2.6 mi	NPS
DE320-001	White Clay Creek (mainstem)	15.6 mi	PS, NPS
DE320-002	Mill Creek	8.3 mi	NPS
DE320-003	Pike Creek	5.4 mi	NPS
DE320-004	Middle Run	4.5 mi	NPS

Assessment ID	Waterbody Name	Size	Potential Source
DE120-003	Upper Christina River	6.3 mi	NPS
DE120-004-01	Lower Christina Creek	8.4 mi	NPS
DE120-004-02	Belltown Run	3.8 mi	NPS
DE120-004-03	Muddy Run	8.0 mi	NPS
DE120-005-01	West Branch Christina River	5.3 mi	NPS
DE120-006	Upper Christina Creek (mainstem)	8.3 mi	NPS
DE120-007-01	Little Mill Creek and Willow Run	5.1 mi	NPS
DE120-007-02	Chestnut Run	2.8 mi	NPS
DE120-L01	Smalleys Pond	30.0 ac	NPS
DE120-L02	Becks Pond	25.6 ac	NPS
DE120-L03	Sunset Pond	40.0 ac	NPS

1.3.2 Sediment Impairments

There are 14 stream segments on Pennsylvania's 1996 Section 303(d) list for sediment or siltation impairment (see Table 1-3). On Pennsylvania's 1998 Section 303(d) list 61 stream segments are listed for sediment or siltation impairments (see Table 1-4). There are no streams listed for sediment impairment in the Delaware or Maryland portions of the Christina River Basin.

Table 1-4. Pennsylvania streams requiring TMDLs for sediment on 1996 Section 303(d) list

Map ID	Segment ID	Stream Name	DEP 5-digit code	Downstr RM	Upstr RM	Assessment ID	Year listed
Watershed=03H (Brandywine Creek)							
5	64954_0.0_1.06	Unt E. Br. Brandywine Cr.	64954	0.0	1.06	970707-1120-GLW	1996
6	00229_24.5_27.3	E. Br. Brandywine Cr.	00229	24.46	27.3	970707-1120-GLW	1996
7	00371_0.0_1.46	Unt E. Br. Brandywine Cr.	00371	0.0	1.46	970707-1120-GLW	1996
8	00372_0.0_0.72	Unt E. Br. Brandywine Cr.	00372	0.0	0.72	970707-1120-GLW	1996
20	00085_10.52_16.4	W. Br. Brandywine Cr.	00085	10.52	16.4	19970925-1348-GLW	1996
Watershed=03I (White Clay Creek and Red Clay Creek)							
65	00465_0.0_7.78	W. Br. White Clay Cr.	00465	0.0	7.78	9408	1996*
SS1	00475_0.0_1.09	Indian Run	00475	0.0	1.09	115	1996
SS2	00462_2.56_14.08	Mid. Br. White Clay Cr.	00462	2.56	14.08	115	1996*
SS3	00462_6.53_8.76	Unt Mid. Br. White Clay Cr.	00462	6.53	8.76	115B	1996*
SS4	00476_0.0_1.56	Unt Mid. Br. White Clay Cr.	00476	0.0	1.56	115	1996
SS5	00477_0.0_1.80	Unt Mid. Br. White Clay Cr.	00477	0.0	1.80	115	1996
SS6	00478_0.0_1.26	Unt Mid. Br. White Clay Cr.	00478	0.0	1.26	115	1996
SS7	00479_0.0_0.63	Unt Mid. Br. White Clay Cr.	00479	0.0	0.63	115	1996
SS8	00480_0.0_0.56	Unt Mid. Br. White Clay Cr.	00480	0.0	0.56	115	1996

* Due to discrepancies between various Pennsylvania Section 303(d) lists, some listing dates may be in error. These marked listings were included on Pennsylvania's 1996 Section 303(d) list and are covered under the above-cited Consent Decree requirements for Pennsylvania.

Table 1-5. Pennsylvania streams requiring TMDLs for sediment (1998 Section 303(d) listings according to Pennsylvania's 2004 Section 303(d) list).

Map ID	Segment ID	Stream Name	DEP 5-digit code	Downstr RM	Upstr RM	Assessment ID	Year listed
Watershed=03H (Brandywine Creek)							
1	00185_0.0_3.31	Unt Buck Run	00185	0.0	3.31	19970710-1040-GLW	1998
2	00186_0.0_0.91	Unt Buck Run	00186	0.0	0.91	19970710-1040-GLW	1998
3	00187_0.0_1.04	Unt Buck Run	00187	0.0	1.04	970710-1340-GLW	1998
9	00076_0.0_3.42	Plum Run	00076	0.0	3.42	971023-1320-GLW	1998
10	00077_0.0_0.73	Unt Plum Run	00077	0.0	0.73	971023-1320-GLW	1998
67	00078_0.0_1.35	Unt Plum Run	00078	0.0	1.35	971023-1320-GLW	1998
11	00079_0.0_1.41	Unt Plum Run	00079	0.0	1.41	971023-1320-GLW	1998
12	00080_0.0_0.18	Unt Plum Run	00080	0.0	0.18	971023-1320-GLW	1998
13	00053_0.0_1.16	Pocopson Creek	00053	0.0	1.16	971021-1108-GLW	1998
14	00054_0.0_0.49	Unt Pocopson Creek	00054	0.0	0.49	971021-1108-GLW	1998
15	00071_0.0_2.22	Radley Run	00071	0.0	2.22	971024-1120-GLW	1998
16	00072_0.0_0.94	Unt Radley Run	00072	0.0	0.94	971024-1120-GLW	1998
17	00236_0.0_2.34	Taylor Run	00236	0.0	2.34	971006-1127-GLW	1998
18	00237_0.0_1.08	Unt Taylor Run	00237	0.0	1.08	971006-1127-GLW	1998
19	00238_0.0_0.34	Unt Taylor Run	00238	0.0	0.34	971006-1127-GLW	1998
	00239_0.0_0.97	Unt Taylor Run	00239	0.0	0.97	971006-1127-GLW	1998
21	00085_28.4_31.4	W. Br. Brandywine Cr.	00085	28.4	31.4	970618-1118-GLW	1998
22	00085_31.4_32.9	W. Br. Brandywine Cr.	00085	31.4	32.9	970618-1340-GLW	1998
23	00224_0.0_4.58	Unt W. Br. Brandywine Cr.	00224	0.0	4.58	970619-1222-GLW	1998
24	00224_4.58_7.16	Unt W. Br. Brandywine Cr.	00224	4.58	7.16	970619-1345-GLW	1998
25	00225_0.0_0.92	Unt W. Br. Brandywine Cr.	00225	0.0	0.92	970619-1222-GLW	1998
26	00226_0.0_1.41	Unt W. Br. Brandywine Cr.	00226	0.0	1.41	970619-1345-GLW	1998
27	00227_0.0_1.31	Unt W. Br. Brandywine Cr.	00227	0.0	1.31	970618-1340-GLW	1998
28	00228_0.0_0.78	Unt W. Br. Brandywine Cr.	00228	0.0	0.78	970618-1340-GLW	1998
Watershed=03I (White Clay Creek and Red Clay Creek)							
29	00434_0.24_3.49	Broad Run	00434	0.24	3.49	971029-1445-ACW	1998
30	00436_0.0_0.85	Unt Broad Run	00436	0.0	0.85	971029-1445-ACW	1998
31	00393_0.50_0.97	Bucktoe Creek	00393	0.50	0.97	971218-1300-ACW	1998
32	00394_0.0_1.12	Unt Bucktoe Creek	00394	0.0	1.12	971218-1300-ACW	1998
33	00395_0.0_1.09	Unt Bucktoe Creek	00395	0.0	1.09	971218-1300-ACW	1998
34	00413_0.0_5.29	E. Br. Red Clay Cr.	00413	0.0	5.29	971023-1050-MRB	1998
35	00414_0.03_3.28	Unt E. Br. Red Clay Cr.	00414	0.03	3.28	971204-1400-ACW	1998
36	00418_0.0_0.84	Unt E. Br. Red Clay Cr.	00418	0.0	0.84	971204-1400-ACW	1998
37	00419_0.0_1.24	Unt E. Br. Red Clay Cr.	00419	0.0	1.24	971203-1051-MRB	1998
38	00432_0.0_3.1	E. Br. White Clay Cr.	00432	0.0	3.1	971113-1335-GLW	1998
39	00432_3.1_5.77	E. Br. White Clay Cr.	00432	3.1	5.77	970506-1320-MRB	1998
40	00432_9.47_10.0	E. Br. White Clay Cr.	00432	9.47	10.0	971119-1116-GLW	1998

Map ID	Segment ID	Stream Name	DEP 5-digit code	Downstr RM	Upstr RM	Assessment ID	Year listed
41	00438_0.0_0.62	Unt E. Br. White Clay Cr.	00438	0.0	0.62	970506-1320-MRB	1998
42	00439_0.0_0.67	Unt E. Br. White Clay Cr.	00439	0.0	0.67	970506-1320-MRB	1998
43	00443_0.0_0.71	Unt E. Br. White Clay Cr.	00443	0.0	0.71	970506-1320-MRB	1998
44	00444_0.0_0.71	Unt E. Br. White Clay Cr.	00444	0.0	0.71	970506-1320-MRB	1998
45	00445_0.0_2.44	Unt E. Br. White Clay Cr.	00445	0.0	2.44	970508-1430-ACE	1998
46	00446_0.0_0.5	Unt E. Br. White Clay Cr.	00446	0.0	0.5	970506-1320-MRB	1998
47	00447_0.0_0.77	Unt E. Br. White Clay Cr.	00447	0.0	0.77	970506-1320-MRB	1998
48	00448_2.49_2.85	Unt E. Br. White Clay Cr.	00448	2.49	2.85	970409-1130-MRB	1998
49	00450_0.0_0.25	Unt E. Br. White Clay Cr.	00450	0.0	0.25	970409-1130-MRB	1998
50	00454_0.0_5.4	Unt E. Br. White Clay Cr.	00454	0.0	5.4	971120-1331-GLW	1998
51	00455_0.0_2.52	Unt E. Br. White Clay Cr.	00455	0.0	2.52	971120-1331-GLW	1998
52	00456_0.0_0.22	Unt E. Br. White Clay Cr.	00456	0.0	0.22	971120-1331-GLW	1998
53	00440_0.0_1.52	Egypt Run	00440	0.0	1.52	970508-1245-ACE	1998
54	00441_0.0_1.38	Unt Egypt Run	00441	0.0	1.38	970508-1245-ACE	1998
55	00442_0.0_0.76	Unt Egypt Run	00442	0.0	0.76	970508-1245-ACE	1998
56	63874_0.0_1.7	Trout Run	63874	0.0	1.7	970506-1425-MRB	1998
57	63875_0.0_0.82	Unt Trout Run	63875	0.0	0.82	970506-1425-MRB	1998
58	63876_0.0_0.21	Unt Trout Run	63876	0.0	0.21	970506-1425-MRB	1998
59	00435_0.0_1.39	Walnut Run	00435	0.0	1.39	971209-1445-ACW	1998
60	00391_0.0_4.6	W. Br. Red Clay Cr.	00391	0.0	4.6	971023-1145-MRB	1998
61	00396_0.0_1.8	Unt W. Br. Red Clay Cr.	00396	0.0	1.8	971023-1315-MRB	1998
66	00373_1.85_3.26	White Clay Creek	00373	1.85	3.26	971216-1230-GLW	1998

1.4 Water Quality Standards

1.4.1 Pennsylvania Water Quality Standards

Pennsylvania Code, Title 25, Chapter 93 sets forth water quality standards for surface waters of the Commonwealth. These standards are based upon water uses which are to be protected and will be considered by PADEP in implementing its authority under the Clean Streams Law and other Commonwealth statutes that authorize protection of surface water quality. With regard to bacteria, waters in the Christina River Basin are designated for contact recreation and potable water supply uses. Contact recreation is classified as swimming season (May 1 through September 30) and non-swimming season (October 1 through April 30). The water quality criteria for bacteria are more stringent during the swimming season. Statewide water uses in Pennsylvania include aquatic life, water supply, and recreation. Waters within the Christina River Basin include exceptional value and high quality waters. The applicable numeric water quality criteria for bacteria in the Pennsylvania portion of the Christina River Basin are shown in Table 1-6.

Implementation of the numeric water quality criteria in Pennsylvania are summarized in Table 1-6 and defined in PA Code, Title 25, Chapter 96.3 as follows:

Chapter 96.3(c): “To protect existing and designated surface water uses, the water quality criteria described in Chapter 93 (relating to water quality standards), including the criteria in Chapters 93.7 and 93.8a(b) (relating to specific water quality criteria; and toxic substances) shall be achieved in all surface waters at least 99 percent of the time, unless otherwise specified in this title. The general water quality criteria in Chapter 93.6 (relating to general water quality criteria) shall be achieved in surface waters at all times at design conditions.”

Chapter 96.3(d): “As an exception to subsection (c), the water quality criteria for total dissolved solids, nitrite-nitrate nitrogen, phenolics and fluoride established for the protection of potable water supply shall be met at least 99 percent of the time at the point of all existing or planned surface potable water supply withdrawals unless otherwise specified in this title.”

In addition to numeric water quality criteria, waters in the Christina River Basin are also subject to narrative criteria stated in PA Code, Title 25, Chapter 93.6 as follows:

Chapter 93.6(a): “Water may not contain substances attributable to point or nonpoint source discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life.”

Chapter 93.6(b): “In addition to other substances listed within or addressed by this chapter, specific substances to be controlled include, but are not limited to, floating materials, oil, grease, scum and substances which produce color, tastes, odors, turbidity or settle to form deposits.”

The TMDL developed for sediment rely on above narrative criteria for their endpoint. Because neither Pennsylvania nor EPA has numeric water quality criteria for sediment, a method was developed to determine water quality objectives that would result in the impaired stream segments attaining their designated uses. The method employed for these TMDLs is termed the “Reference Watershed Approach.” The Reference Watershed Approach compares two watersheds, one attaining its uses and one that is impaired based on biological assessments. Both watersheds must have similar land use/cover distributions. Other features such as base geologic formation should be matched to the extent possible. However, most of the variations can be adjusted in the model. The objective of the process is to reduce the loading rate of pollutants in the impaired stream segment to a level equivalent to the loading rate in the non-impaired, reference stream segment. This load reduction will result in conditions favorable to the return of a healthy biological community to the impaired stream segments.

Table 1-6. Pennsylvania water quality standards (PA Code, Title 25, Chapter 93.7)

Pollutant	Designated Use	Criteria		Period
Fecal Coliform Bacteria (cfu/100 mL)	Water Contact Recreation (statewide)	Maximum geometric mean of 200 cfu per 100 mL, based on a minimum of 5 consecutive samples each sample collected on different days during a 30-day period.	No more than 10% of the total samples taken during a 30-day period may exceed 400 cfu per 100 mL.	May 1 to Sep 30
		Maximum geometric mean of 2,000 cfu per 100 mL, based on a minimum of 5 consecutive samples each sample collected on different days during a 30-day period		Oct 1 to Apr 30
	Potable Water Supply (statewide)	Maximum of 5,000 cfu per 100 mL as a monthly average value, no more than this number in more than 20 samples collected during a month, nor more than 20,000 cfu per 100 mL in more than 5% of the samples		year round
Total Dissolved Solids TDS (mg/L)	Potable Water Supply (statewide)	maximum = 750	monthly avg. = 500	year round

cfu – colony forming units

1.4.2 Delaware Water Quality Standards

Delaware amended its water quality standards on July 11, 2004. EPA approved the revised standards for *enterococci* bacteria in November 2004. The Christina River and Brandywine Creek are designated as public and industrial water supply, primary and secondary contact recreation, and for fish, aquatic and wildlife. Portions of the Brandywine Creek are also designated as ERES waters.

The Delaware water quality standards contain criteria for bacteria for primary and secondary contact waters as well as shellfish harvesting waters. There are no shellfish harvesting waters in the Christina River Basin. Waters in the Christina River Basin within Delaware are designated for both primary and secondary contact recreation uses as shown in Table 1-6.

Table 1-7. Delaware bacteria water quality standards, *enterococcus* bacteria (cfu/100 mL).

Waterbody Use Designation	Criteria	
	Single-Sample Value	Geometric Mean
Primary contact recreation fresh waters	185	100
Primary contact recreation marine waters	104	35
Secondary contact recreation fresh waters	925	500
Secondary contact recreation marine waters	520	175

Delaware is committed to bacteria source tracking to be able to determine the source of bacteria causing impairments under the supposed assumption that bacteria from wildlife sources does not pose as great a threat to human health as bacteria from human sources does. However, DNREC does not have information from the Christina River and Brandywine Creek Watersheds on which to estimate the wildlife contribution to the bacteria impairment. Therefore, no reductions to monitoring data will be taken.

“Marine waters” are defined as waters of the state that contain natural levels of salinity greater than five parts per thousand (ppt). All waters within the Christina River Basin have natural salinity levels less than five ppt. Therefore, the primary contact fresh-water criteria for *enterococcus* bacteria were used as the target end points for this TMDL.

1.4.3 Maryland Water Quality Standards

All surface waters shall be protected for water contact recreation, fishing, and protection of aquatic life and wildlife. For fresh waters, Maryland uses either *enterococci* or *E. coli* as the bacteria indicator. For waters not designated as beaches, only the steady state geometric mean indicator density for *enterococci* is 33 counts/100 mL and for *E. coli* 126 counts/100 mL is the applicable criterion.